Water Quality Sampling and Educational Outreach in the Barataria-Terrebonne Basins

(Bayou Folse Watershed-Subsegment 120302)

September 2018

A Final Report of the:

Barataria-Terrebonne National Estuary Program

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Prepared for the:

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LDEQ La Gov no. 2000283583

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Project Overview

Project Title: Water Quality Sampling and Educational Outreach in the Barataria-Terrebonne Basins

Project Objective:

The main goal of this project was to improve the water quality in the Bayou Folse watershed by reducing the nutrient and bacteria loading in the area surrounding the watershed. The objectives were to perform water quality sampling, education outreach to the public, identifying hot spots and establish a relationship with local government agency to enable home sewage inspections.

Project Area: Bayou Folse Watershed, Lafourche Parish, LDEQ subsegment 120302

Start Date: Oct 1, 2016 **End Date:** September 30, 2018

Executive Summary

Bayou Folse watershed is located in coastal southeastern Louisiana in Lafourche Parish. It is located in an inter-distributary watershed between the Bayou Lafourche and Bayou Blue Ridges, and between the City of Thibodaux and the town of Lockport. The watershed is predominantly made up of wetlands but contains pastureland, row crop agriculture, and individual wastewater treatment system land uses that contribute to degraded and polluted water flowing out of the watershed into company canal to the southeast. Over two years between October 2016 and September 2018, the project entitled, "Water Quality Sampling and Educational Outreach in the Barataria-Terrebonne Basins" collected water quality data at 10 sites along a transect of the Bayou Folse watershed, conducted various water quality education events for the general public, and worked with local governmental organizations to form an agreement for future work that can address malfunctioning home sewage systems in the watershed. Over the course of the project, Barataria Terrebonne National Estuary Program (BTNEP) staff and volunteers conducted 42 sampling events that included both field sampling parameter collection and grab samples for laboratory analysis. BTNEP staff also attended 74 education events where they shared information about Bayou Folse and water quality. Water quality sampling data indicates that the Bayou Folse Watershed is a highly impacted area with respect to its ability to support its designated uses and that there are areas in the watershed contributing runoff. The Bayou Lafourche Freshwater District (BLFWD) provided their interest and authority to work in the future with BTNEP and Louisiana Department of Environmental Quality (LDEQ) in identifying and correcting malfunctioning home sewage systems.

Introduction

The Bayou Folse Watershed area consists of various land use types including pastureland and residential areas under forced drainage (Figure 1). Areas outside of the towns and municipalities in the Bayou Folse Watershed are generally without community sewage treatment and rely on individual home sewage treatment systems for residential wastewater treatment. These may be package plants or individual systems. Poor maintenance of home sewage systems can lead to bacteria and nutrient loading. There are more than 4,600 individual home systems in this watershed (Louisiana Department of Health data). Visual observations indicate that many of these systems are poorly functioning and not maintained.

Ten sampling sites were established as part of this project. During the initial data collection, LDEQ scientists used GIS software to identify areas draining to the 10 sampling sites. Initial results were analyzed to determine which geographic areas are associated with sampling locations showing higher concentrations of nutrients and bacteria, and low DO. The identified areas were mapped, and maps and analysis shared with the contractor to assist in education/outreach activities and implementation of BMPs. Locations of the 10 sampling sites can be seen in Figure 2.

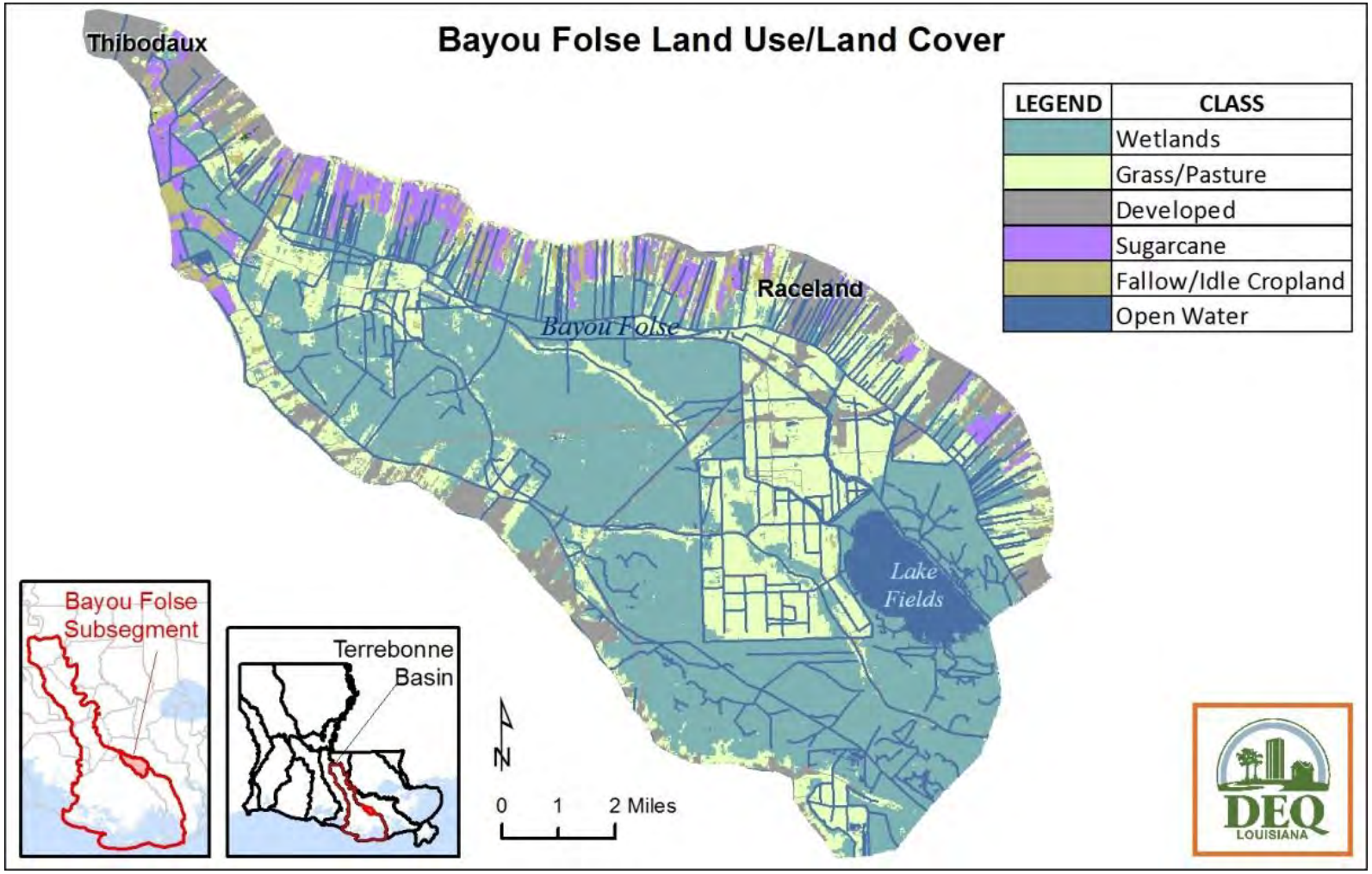

Figure 1 Land Use Map of Bayou Folse Watershed

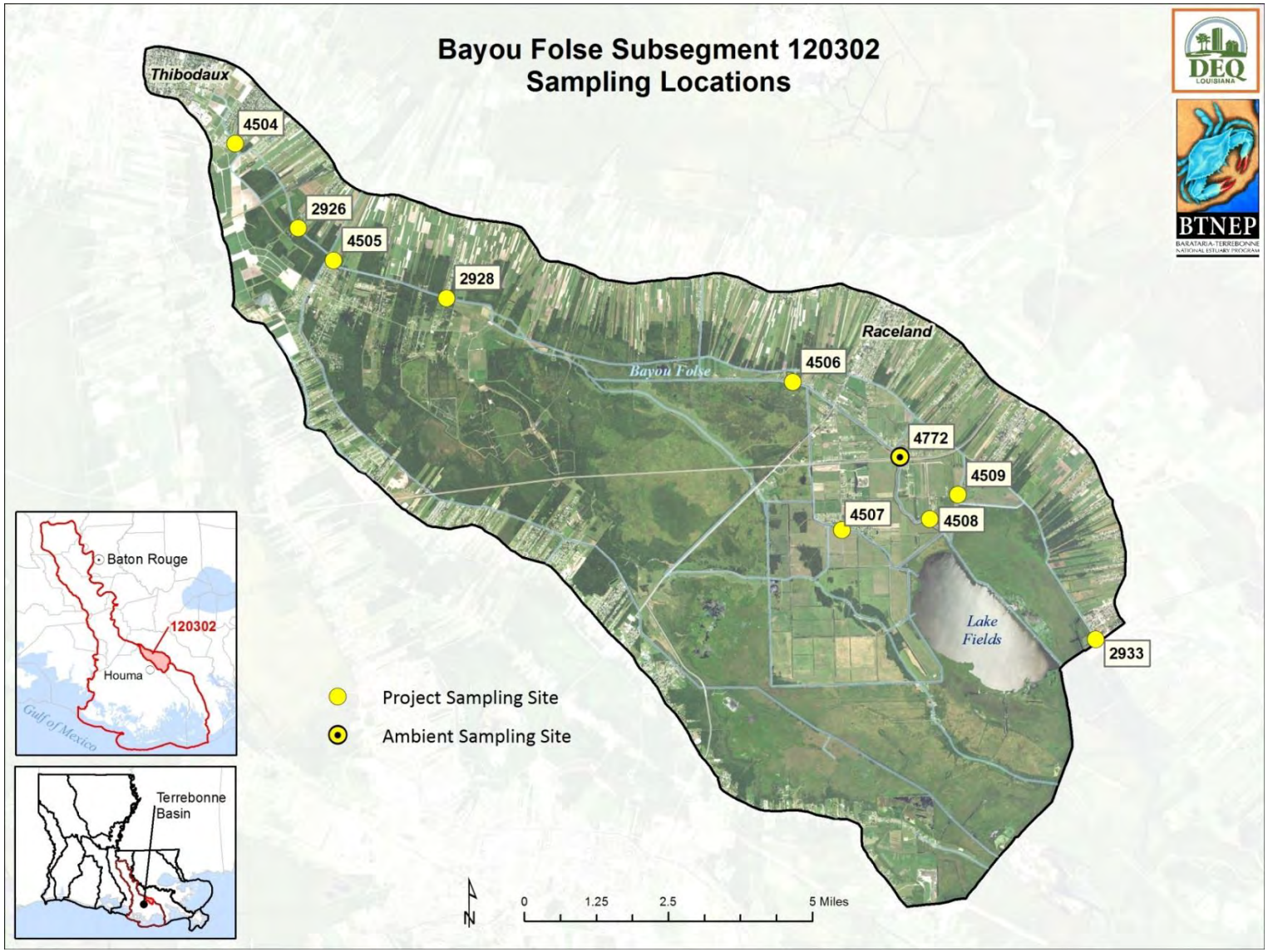

Figure 2 Map of sampling sites in the Bayou Folse watershed.

Project Goals, Objectives & Activities

The main goal and focus of this contract was to reduce nonpoint source (NPS) pollution with the objectives of improving surface water quality, restoring support for Clean Water Act (CWA) designated uses and maintaining healthy waters; thus, reducing the number of watersheds listed as impaired and preventing the listing of new watersheds on the Louisiana Water Quality Integrated Report impaired water body list.

Specific Objectives of the project include the following:

- To conduct water quality sampling
- To conduct general water quality education and outreach to the public
- To identify hotspots with the highest concentration of bacteria and nutrients
- To establish a relationship with local government agency to enable home sewage inspections

BTNEP collected water quality samples and in situ readings at 10 locations for field parameters, fecal coliform (FC), and nutrients using USEPA-approved methods. BTNEP staff monitored the Bayou Folse watershed for field parameters and water chemistry, and collected grab samples for laboratory analysis (FC and nutrients (phosphorus and nitrogen)) on a twice-monthly basis for the duration of the project.

The outcomes of this monitoring effort were a quantitative understanding of existing water quality conditions throughout the watershed, knowledge of where low dissolved oxygen (DO), high bacteria and high nutrient concentrations occur, and an identification of geographic areas contributing NPS loads that impact water quality. In the next phase of this project, implementation of a home sewage inspection program should lead to measurable changes in water quality conditions. It is expected that this data will be used by LDEQ and its partners to improve overall watershed health and potentially restore Bayou Folse to fully meet its primary contact recreation (PCR) and to monitor secondary contact recreation (SCR) for fish and wild life propagation (FWP) designated uses. Future use of monitoring data from this project will include use of the data to determine water quality conditions before, during, and after OSDS education/outreach and NRCS NWQI activities. This data will be used by LDEQ for watershed planning, shared with watershed stakeholders, and potentially used for water quality assessments to support restoration. Please see the section on Results for more details about data.

BTNEP also conducted general water quality education and outreach to the public. A large part of making changes in a watershed toward restoration is establishing the idea that there is a problem and providing practical solutions. Water quality education provides a campaign in the public eye that establishes that there are a set of problems and gives them the tools and

information that they can use in their lives to enact change. Please see the section on Education and Outreach for more details.

A vital component of this project was to establish a relationship with a local government agency to enable home sewage inspections. The local government agency had to have the authority to perform inspections of home sewage systems in the Bayou Folse watershed. This objective was accomplished by systematically meeting with members of the Lafourche Parish Government and the Bayou Lafourche Freshwater District (BLFWD). These efforts are described in the section on Local Government Participation.

Materials and Methods

QAPP and Sampling Plan

The Bayou Folse Sampling Plan for this project was developed as project specific part of the Quality Assurance Project Plan (QAPP) Umbrella developed by LDEQ with EPA approval. The sampling plan contains all site specific information and protocols for the project. Please reference the Sampling Plan, "Bayou Folse (From headwaters to Company Canal); Subsegment 120302; Sampling Plan (SP)_6002_r02 Operating under (QAPP) #3050, " for all site and sampling protocol information. The Bayou Folse Sampling Plan can be provided upon request. For LEAU numbers that correspond to site numbers and site descriptions see Table 2.

Table 2 Bayou Folse LEAU numbers, site numbers, and descriptions of sampling sites

LEAU Site No	Field Site No.	Description
4504	1	Bayou Folse at Rue Pelletier above the Waste Water Plant, and above the Nicholls University Farm
2926	2	Bayou Cutoff at south side of Hwy 1 on Supercharge Dr
4505	3	Bayou Cutoff at bridge on Lefort Road
2928	4	Bayou Cutoff at St. Charles Bypass, East of Bayou Vista subdivision.
4506	5	Bayou Folse at Theriot Canal
4507	6	Bayou DuMar at Hwy 653
4508	7	Bayou Folse at Lake Drive Pump Station in Raceland

4509	8	Bayou Cutoff at Butch Hill Pump Station off of Hwy 652
2933	9	Forty Arpent Canal at Lockport where Barios Drive meets the Forty Arpent Canal at the outfall of the Coastal Pump Station
4772	10	Bayou Folse at U.S. 90 service road south of Raceland. (WQN Site)

Field Sampling

BTNEP staff worked with volunteers to collect field and grab samples at 10 sites in the Bayou Folse Watershed. Each sampling site was characterized during one sampling trip per quarter according to LDEQ field site characterization sheets. Site characterization information can be provided upon request.

Field parameter measurements were collected at each of the sites throughout the time of the project. October 26, 2016 was the first sampling event. Beginning in November 2016 through June 2018 BTNEP staff sampled two events per month except for January 17, 2018. The temperatures for that day were very low resulting in unsafe conditions for driving and sampling.

After the first two initial sampling events on October 26, 2016 and November 9, 2016, sampling sites 3 (LEAU 4505) and 10 (LEAU 4772) were relocated. Their original locations were deemed inaccessible or dangerous as sampling sites. Data from these initial sampling events at these two sites were not used in this report.

For each site, the following field parameters were collected using a Hydrolab model P1080 and NX7 Handheld: pH, dissolved oxygen (DO), temperature, conductivity and salinity. In addition, the following field parameters were collected for each site: secchi disk and tapedown stage height.

Velocity measurements, which included bi-directional flow, were collected for 23 sampling events between 6/28/2017 and 7/2/2018 from the ambient site 10, LEAU 4772. The technique involves dropping a drogue (orange) on the up flow side of the bridge (upstream side of the bridge for downstream flow; downstream side of the bridge for upstream flow) and recording the time for the orange to flow out from under the opposite side of the bridge. The width of the bridge was measured from the first line of site position to the second line of site position. This distance was measured as 32.8 feet. Velocities were calculated as feet per second. Replicate velocities were measured in three cross sections of the waterway: left descending, middle, and right descending sections. If velocity was too low to measure in either the left or right descending sections, then a replicate was measured for the middle section. If one of the three sectional velocities appeared to be inconsistent with other measurements, then a replicate was

measured in that section. See the subsection "Velocity and Flow" under the "Results" section for more details and results of the measurements.

Flow calculations were dependent upon initial measurements made during field work conducted by the LDEQ project manager, Aimee Preau, BTNEP staff, and LDEQ contract hydrologist, Max Forbes on 5/17/2017. Direct measurements of flow were made that day by Max Forbes using his bridge flow measurement apparatus. A tape down measurement was also made that corresponded to stage height for this event. This tape down measurement was then used as a reference point for calculating total area at the site by adding or subtracting tape down measurements during subsequent sampling events where velocities were measured using the drogue technique as described above. The velocities multiplied by the adjusted areal calculations, which yielded flow in cubic feet per second. These values were multiplied by 0.92, which is a coefficient determined by Max Forbes to adjust for the curvature of the stream at the bridge at site 10, LEAU 4772.

Grab Samples

For laboratory parameters (fecal coliform bacteria, TKN, total phosphorus, nitrate-nitrite) the data are reported through July 18, 2018. For each site, grab samples for fecal coliform bacteria and nutrients (nitrogen and phosphorous) were collected according to the sampling plan. The standard methods used to analyze these parameters are included in Table 3 below;

Table 3 Standard methods used for laboratory analysis of grab samples

Parameter	**EPA Method**	**Laboratory**
Total Kjeldhal Nitrogen	351.2	Pace Analytical
Nitrate-Nitrite	SM4500-NO3-F	Pace Analytical
Total Phosphorus	365.4	Pace Analytical
Fecal Coliform Bacteria	SM9222D	Petroleum Laboratories Inc.

Data Analysis Methods

Field and laboratory data were entered into Excel spreadsheet format and organized using the Pivot table function for each parameter. Minimum values, maximum values, mean average, and sum were calculated by site for each parameter. Number and percentage of events greater than the primary contact recreation (PCR) standard (sampling events collected during May through October with fecal coliform bacteria greater than 400 CFUs) and the secondary contact recreation (SCR) standard (sampling events collected during January through December with FC greater than 2000 CFUs) were calculated for FC data. Number and percentage of events greater than the fish and wildlife propagation (FWP) standard (sampling events collected with DO less than 5.0 mg/L) were calculated for dissolved oxygen data. Raw data were graphed by site for each parameter. The sum of values and mean average by site and by date were graphed for each parameter. The percentage of exceedances for PCR and SCR was graphed for FC. The percentage of exceedances for FWP was graphed for DO.

Results

Data

For field parameters (DO, salinity, temperature, pH, clarity, tape down) and laboratory parameters (fecal coliform bacteria, TKN, total phosphorus, nitrate-nitrite), the data includes all events collected from October 26, 2016 through July 18, 2018. All raw tabulated data are in Electronic Deliverable Data (EDD) form files and can be provided upon request.

Dissolved Oxygen

Bayou Folse has a standard for dissolved oxygen (DO) that is 5.0 mg/L throughout the year. According to the data collected since the beginning of the project, many of the sites across sampling events along Bayou Folse are being measured as having DO below the 5.0 mg/L FWP standard (Table 4). Based on the number of DO events below 5.0 mg/L, Sites 2 and 1 have the highest number of sampling events or exceedances below the 5.0 mg/L standard. Site 9 had the lowest number of exceedances (Figures 3 and 4).

Table 4 Percent exceedances (DO< 5.0 mg/L), min, max, and mean average for DO

Site number	LEAU Numbers	% Exceedance FWP; DO <5 (mg/L)	Min DO (mg/L)	Max DO (mg/L)	Mean Average DO (mg/L)
1	4504	62%	1.31	8.2	4.5
2	2926	64%	0.33	10.94	4.7
3	4505	45%	1.05	11.01	5.0
4	2928	52%	0.35	9.65	4.5
5	4506	50%	0.31	9.42	4.6
6	4507	43%	0.28	10.62	5.1
7	4508	36%	0.26	11.47	5.8
8	4509	57%	0.28	8.38	4.9
9	2933	33%	0.65	16.84	6.6
10	4772	45%	0.29	10.85	5.3

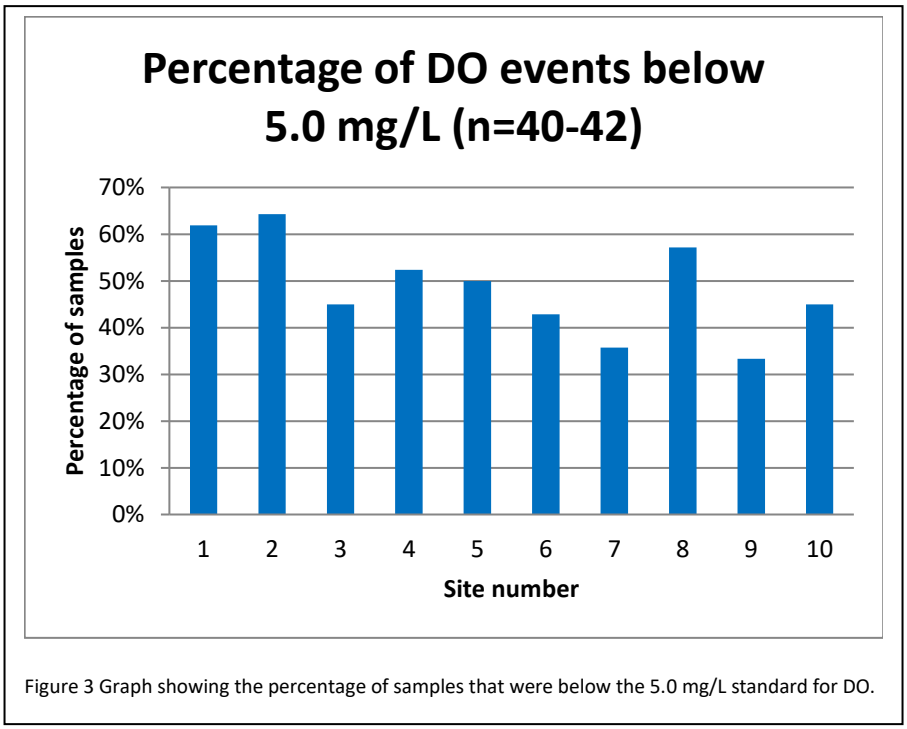

Figure 3 Graph showing the percentage of samples that were below the 5.0 mg/L standard for DO.

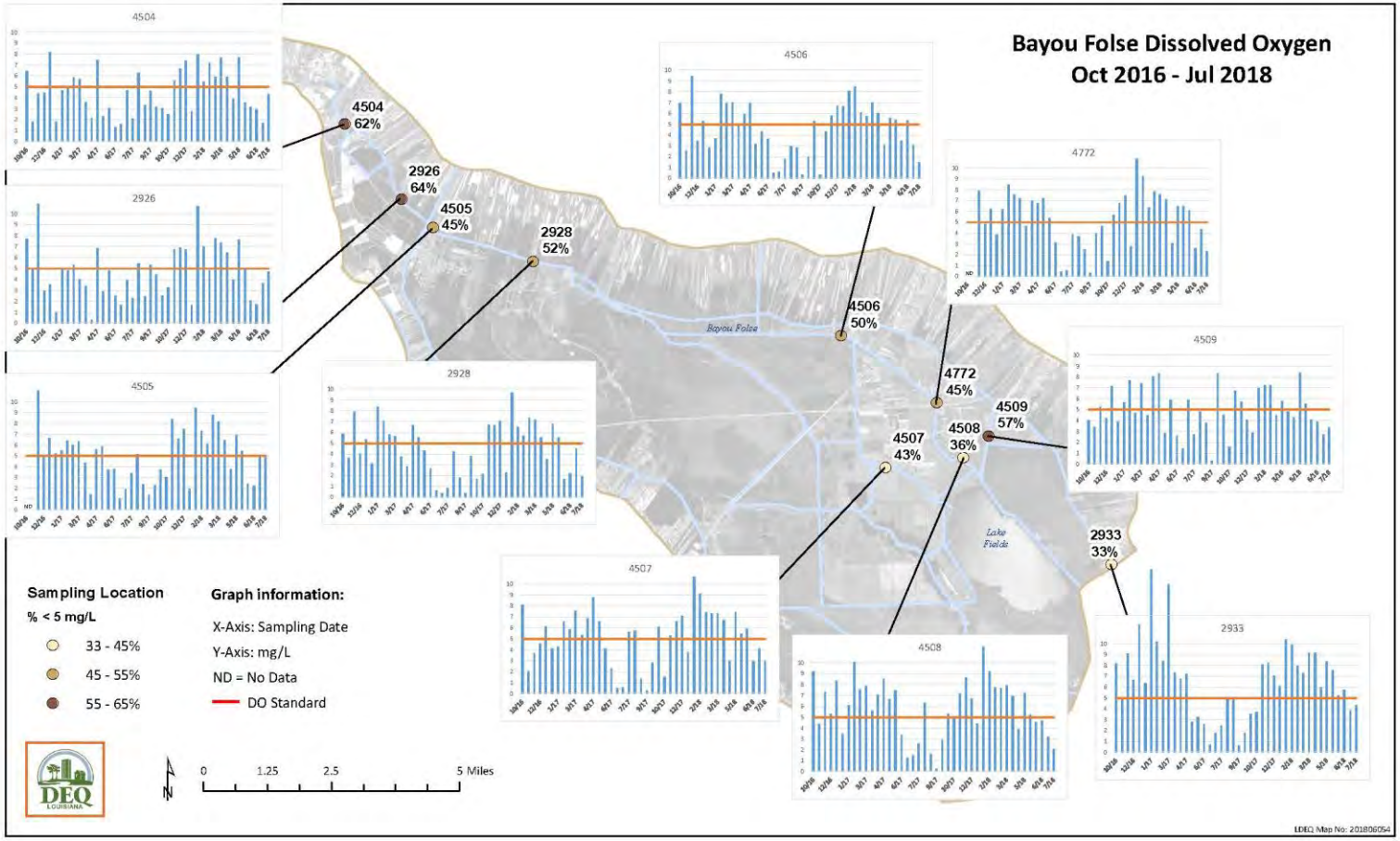

Figure 4 Map of DO by sampling site in the Bayou Folse watershed

Salinity

Salinity for all sites was below 0.25 ppt. Each sample site was biologically fresh for all sampling events. However, there are patterns that have developed in the data. The highest values are associated with site numbers 1, 2, 8 and 9 (Figure 5). Site 1 is located near a culvert draining a neighborhood under active construction and is uppermost site in the watershed. Site 8 is at the Butch Hill boat launch and is near the bottom of the watershed. The site is in a dead end canal just below a pumping station and receives southerly wind-driven water frequently during the year. Site 9 is the lowest site in the watershed and has a direct connection to the Company Canal which connects into the Houma Navigational Canal, which is a conduit for saline waters. However, based on the data analyzed for this report, there were no salinity levels above what would be considered biologically fresh water.

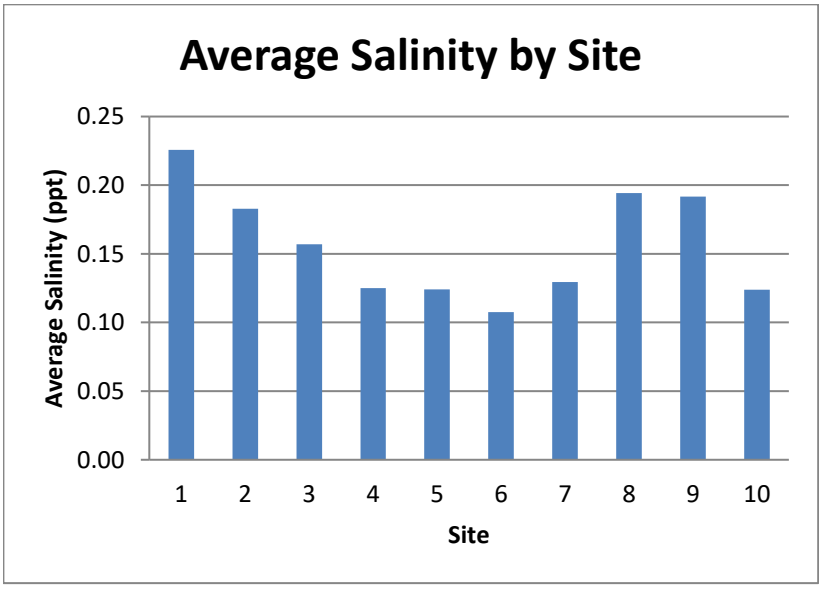

Figure 5 Graph showing the average salinity by site.

Temperature

Temperatures analyzed for this report tended to follow the normal seasonal trends (Table 5 and Figure 6). One sampling event scheduled for 1/17/2018 had to be cancelled due to icing of the roads. The sampling event on 1/3/2018 was the lowest recorded values during this project. Temperature values during the reporting period were consistent with seasonal trends. Otherwise there does not seem to be any unusual values for this project.

Table 5 Average, Minimum and Maximum Temperatures

Site number	LEAU Numbers	Average Temperature (ºC)	Min Temp (ºC)	Max Temp (ºC)
1	4504	22.3	8.1	29.8
2	2926	22.5	6.6	30.5
3	4505	22.4	6.1	31.1
4	2928	22.6	6.6	30.3
5	4506	22.9	6.9	31.4
6	4507	23.0	6.0	31.9
7	4508	23.4	6.8	32.3
8	4509	23.7	9.3	33.1
9	2933	22.8	7.5	31.8
10	4772	23.2	6.6	32.3

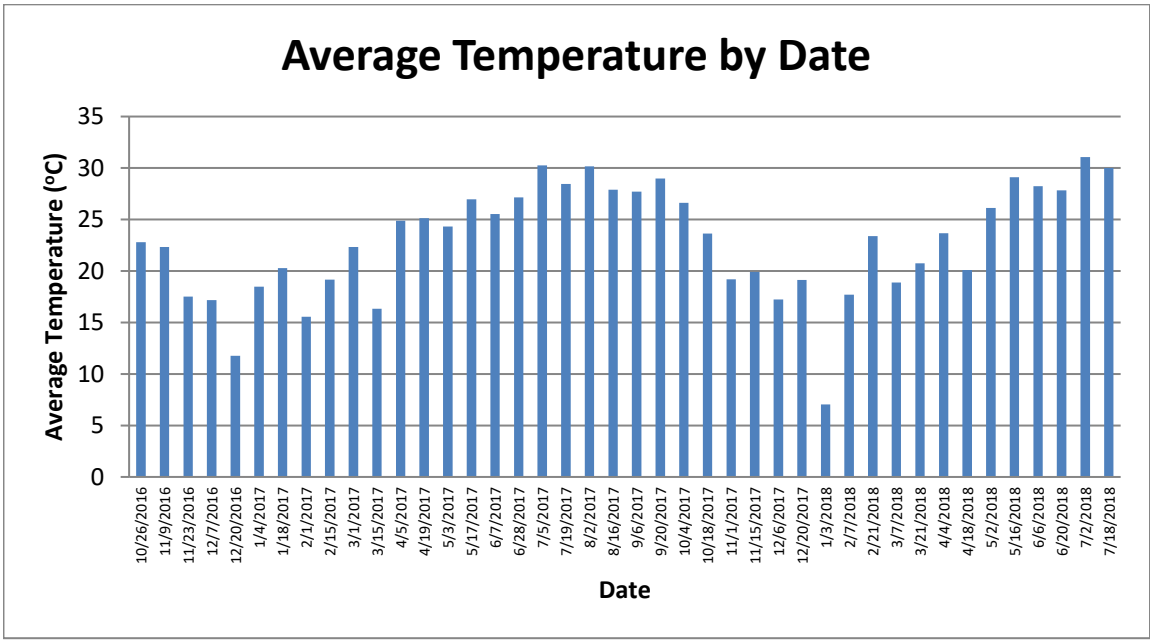

Figure 6 Graph of temperature averaged by date

pH

Values for pH varied between 6.10 and 8.92 for sampling events analyzed for this report (Table 6). The lowest minimum value was for site number 6 at 6.10. The highest value was for site number 9 at 8.92. These values offer a dramatic range of pH values for this watershed. On the low end, a pH value of 6.10 is probably driven by organic acids from marsh and swamp drainage in the watershed. This is corroborated by the black water that was frequently observed during sampling events. On the high end, a pH value of 8.92 is probably driven by a combination of marine waters containing carbonates, and CO_2 consumption as part of the photosynthetic cycle of algae and plants, which drives pH to these high values (Figures 7 and 8).

Table 6 Average, Minimum, and Maximum pH values

Site number	LEAU Numbers	pH Average	Min pH	Max pH
1	4504	7.19	6.64	7.63
2	2926	7.41	6.68	8.20
3	4505	7.28	6.51	8.28
4	2928	7.14	6.13	7.81
5	4506	7.19	6.26	7.81
6	4507	7.14	6.1	7.89
7	4508	7.38	6.33	8.06
8	4509	7.14	6.31	7.81
9	2933	7.68	6.13	8.92
10	4772	7.15	6.25	8.06

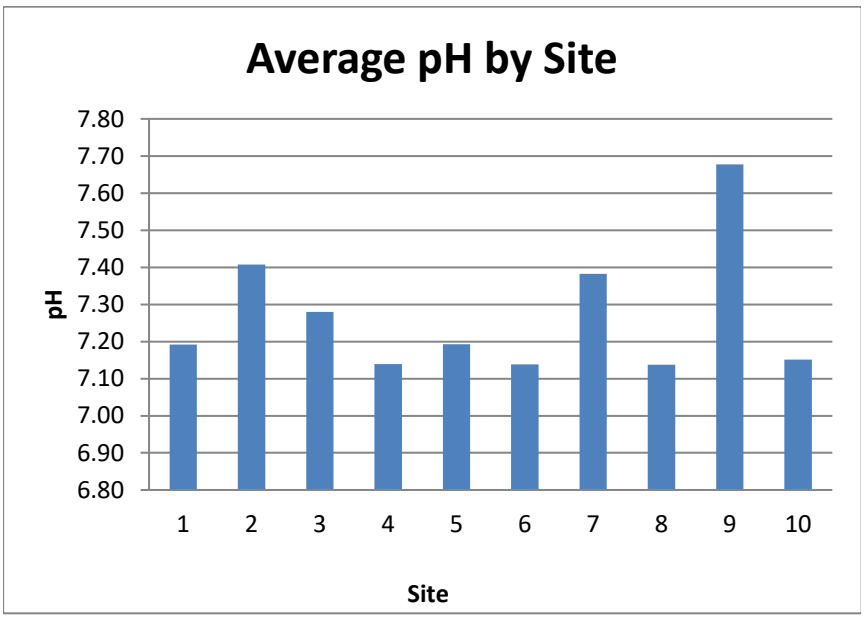

Figure 7 Graph of pH by site

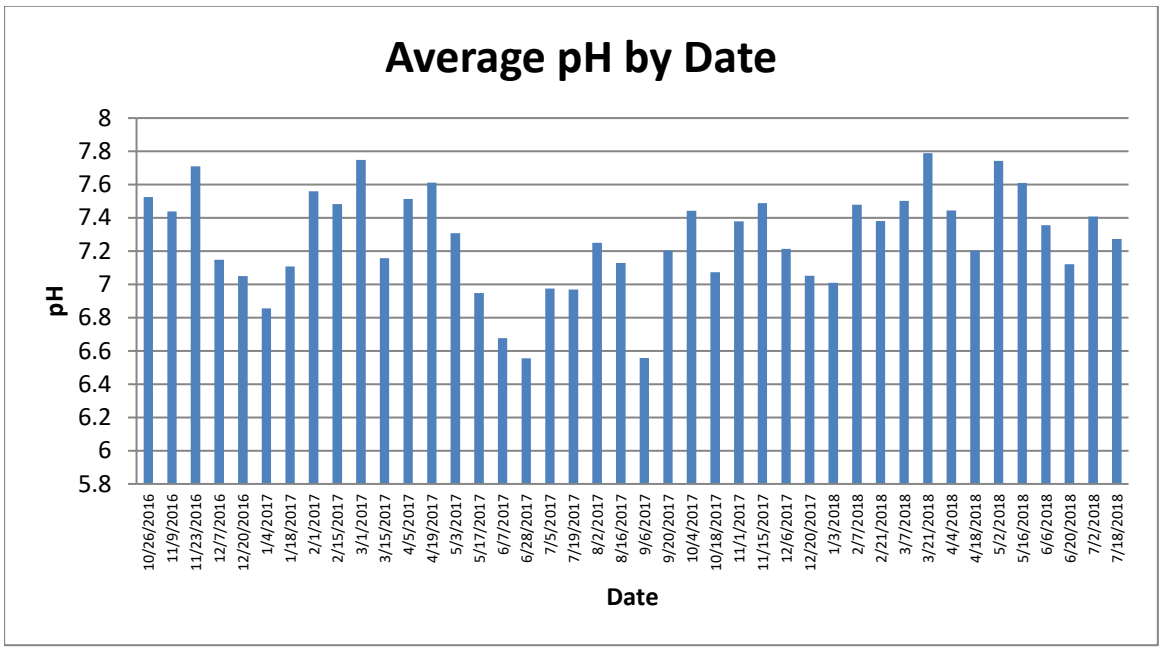

Figure 8 Graph of pH by date

Water Clarity

Measurements for water clarity ranged between 0 to 37.1 inches (Table 7). Sites 9 and 8 have the highest 2 values for water clarity; whereas the graph of average water clarity by site shows sites 5 and 8 having the highest 2 values (Figure 9). Otherwise, there appears to be no discernable trend for water clarity for this data set (Figures 9 and 10).

Table 7 Average, Minimum, and Maximum Water Clarity

Site number	LEAU Numbers	Average	Min Clarity (in)	Max Clarity (in)
1	4504	12.2	3.7	25.2
2	2926	10.5	4.0	23.9
3	4505	10.4	3.5	20.4
4	2928	12.4	1.5	29.4
5	4506	14.8	7.0	28.7
6	4507	11.5	0.0	20.5
7	4508	12.6	4.2	20.0
8	4509	16.5	4.5	35.4
9	2933	15.1	0.0	37.1
10	4772	12.3	6.1	19.8

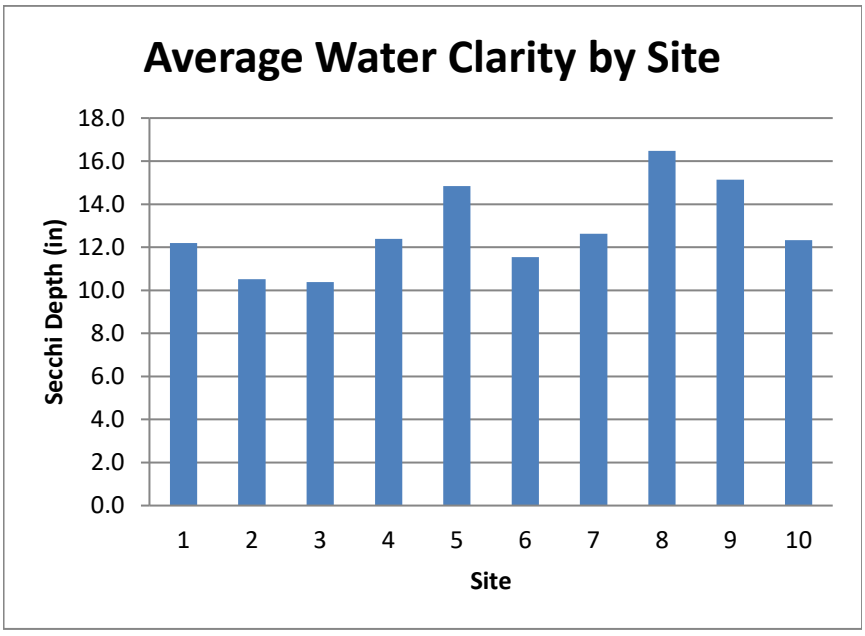

Figure 9 Graph of average water clarity by site

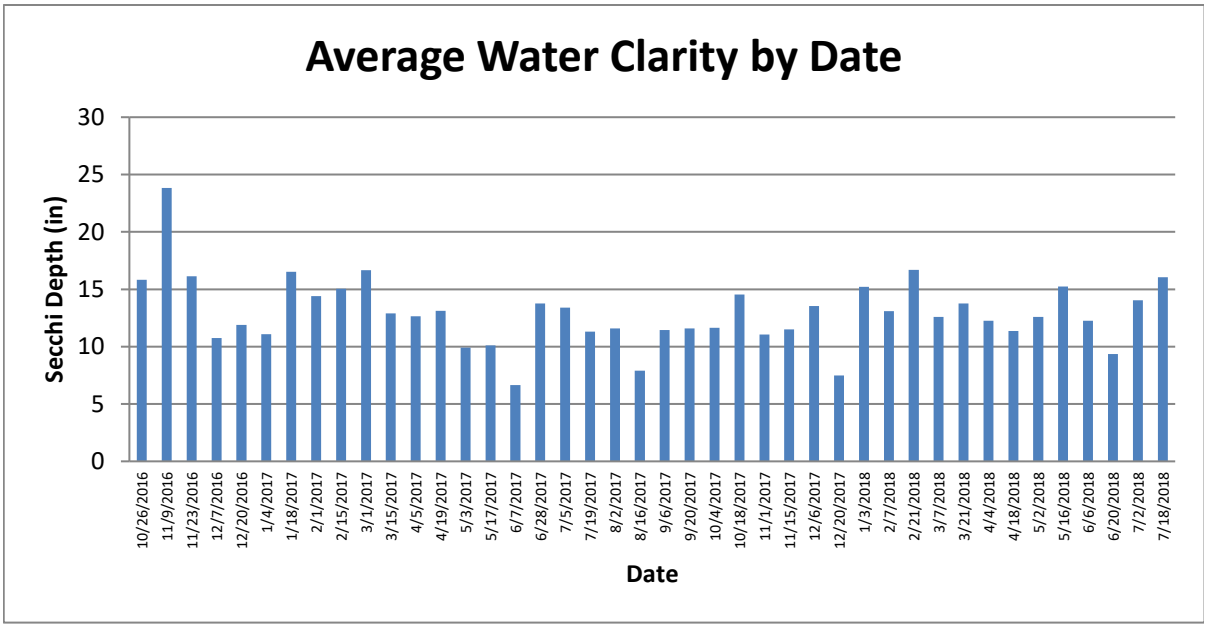

Figure 10 Graph of water clarity by date

Fecal Coliform Bacteria

Data for fecal coliform bacterial (FC) ranged between 1 and 7100. Values that are equal to or greater than 6000 CFUs represent a value that was at or above detection limits for the CFU laboratory method (Table 8). Table 9 shows the results of data analysis for the SCR (Jan-Dec) standard and the PCR (May-Oct) standard. It summarizes the percentage of times that each site exceeded standards for each standard. The SCR standard was exceeded 12% of the time in site 1; 8% of the time in sites 3 and 10; 7% of the time in sites 2 and 8; and 2% in sites 4 and 7 for this data set. The PCR standard was exceeded at every site for this data set with the highest value in site 1 for 53% of the time and the lowest value in site 6 at 11% of the time. Figure 11 shows the percentage of FC bacteria exceedances for the SCR and PCR standards. Figure 12 shows the average of FC by site and represents the values from all sampling events averaged (mean) for each site. From this graph, the highest average amount of FC was recorded from Sites 1 and 2. Figure 13 shows the average of FC by date and represents the values from all sampling sites averaged for each sampling event. From this graph, the sampling dates with substantially higher values were on 12/20/2016, 1/4/2017, and 8/16/2017. These events have average values that are much higher than the other sampling events. It is unclear as to what would cause these episodically high values. These high values could be related to large rainfall events that occurred immediately prior to the sampling events. Figure 14 summarizes the exceedances for the PCR standard by site overlaid upon a map of the watershed.

Table 8 Average, Minimum, Maximum, Sum, Mean Fecal Coliform Bacteria (CFUs/100 mL; n = 40-42)

Site number	LEAU Numbers	Min FC (CFUs/100 mL)	Max FC (CFUs/100 mL)	Sum Total (CFUs/100 mL)	Mean Average (CFUs/100 mL)
1	4504	19	6000	36244	863
2	2926	10	6000	26900	640
3	4505	15	6000	23528	588
4	2928	1	5500	17389	414
5	4506	10	1080	12362	294
6	4507	10	1800	9318	222
7	4508	10	6000	16210	386
8	4509	10	7100	24414	581
9	2933	10	960	10613	253
10	4772	31	2900	18342	459

Table 9 Percentage Fecal Coliform Bacteria exceedances of PCR (May-Oct) and SCR (Jan-Dec) standards.

Site number	LEAU Numbers	SCR (n=40-42); FC>2000	PCR (n=19); FC > 400
1	4504	12%	53%
2	2926	7%	32%
3	4505	8%	44%
4	2928	2%	37%
5	4506	0%	37%
6	4507	0%	11%
7	4508	2%	26%
8	4509	7%	32%
9	2933	0%	37%
10	4772	8%	28%

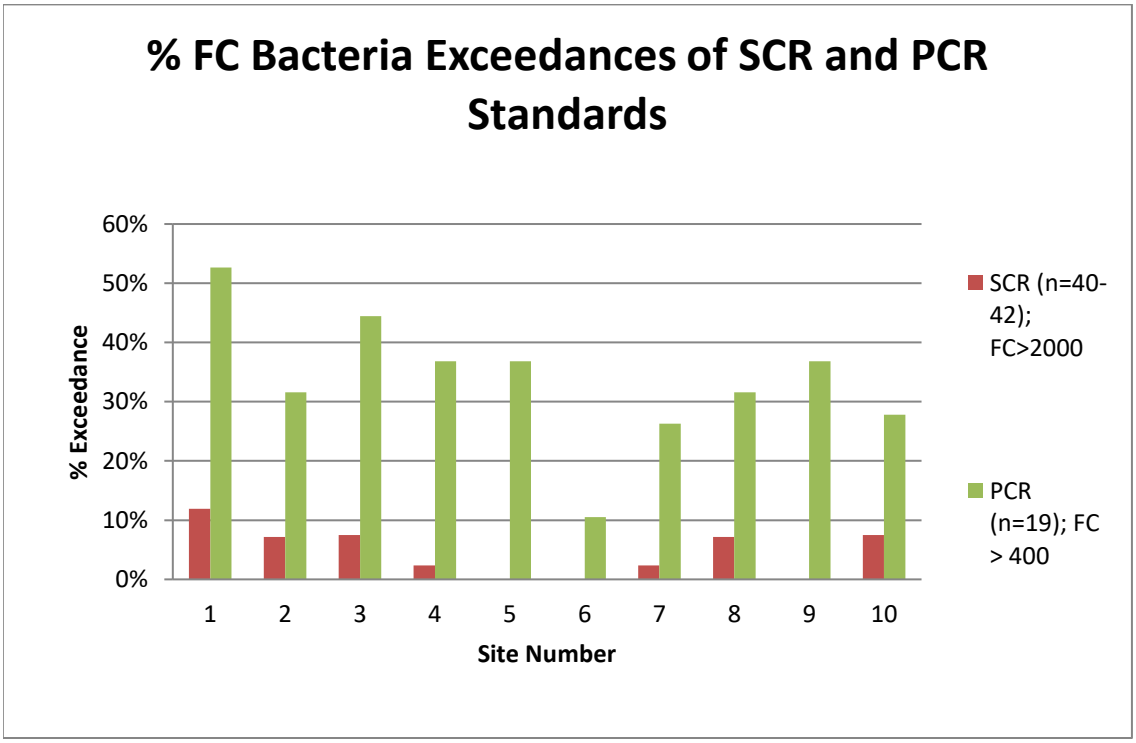

Figure 11 Graph showing the average of Fecal Coliform Bacteria for each site

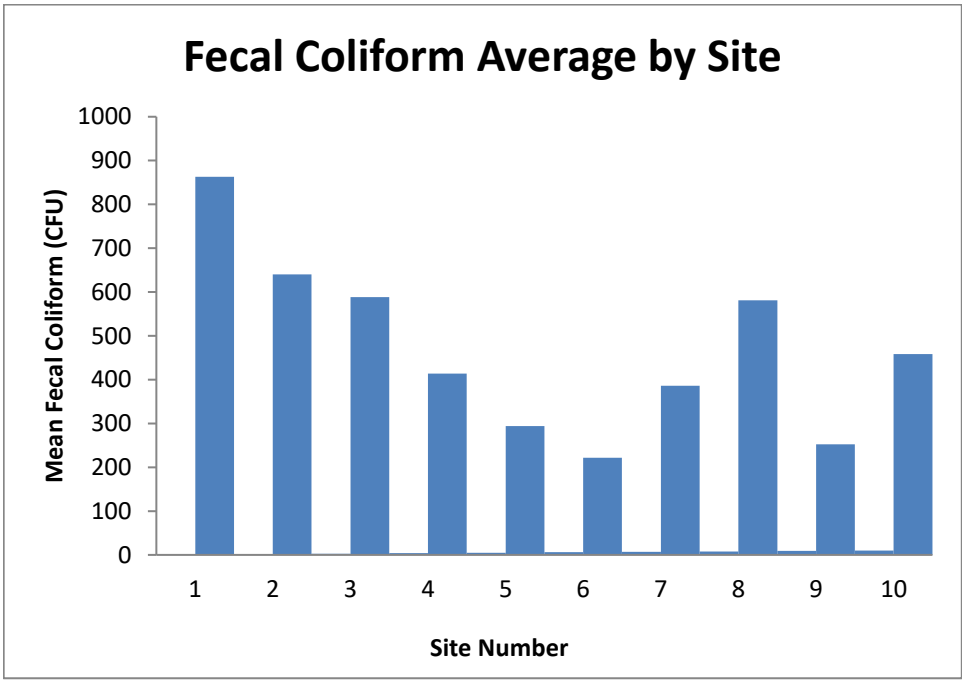

Figure 12 Graph showing the average of Fecal Coliform Bacteria for each site

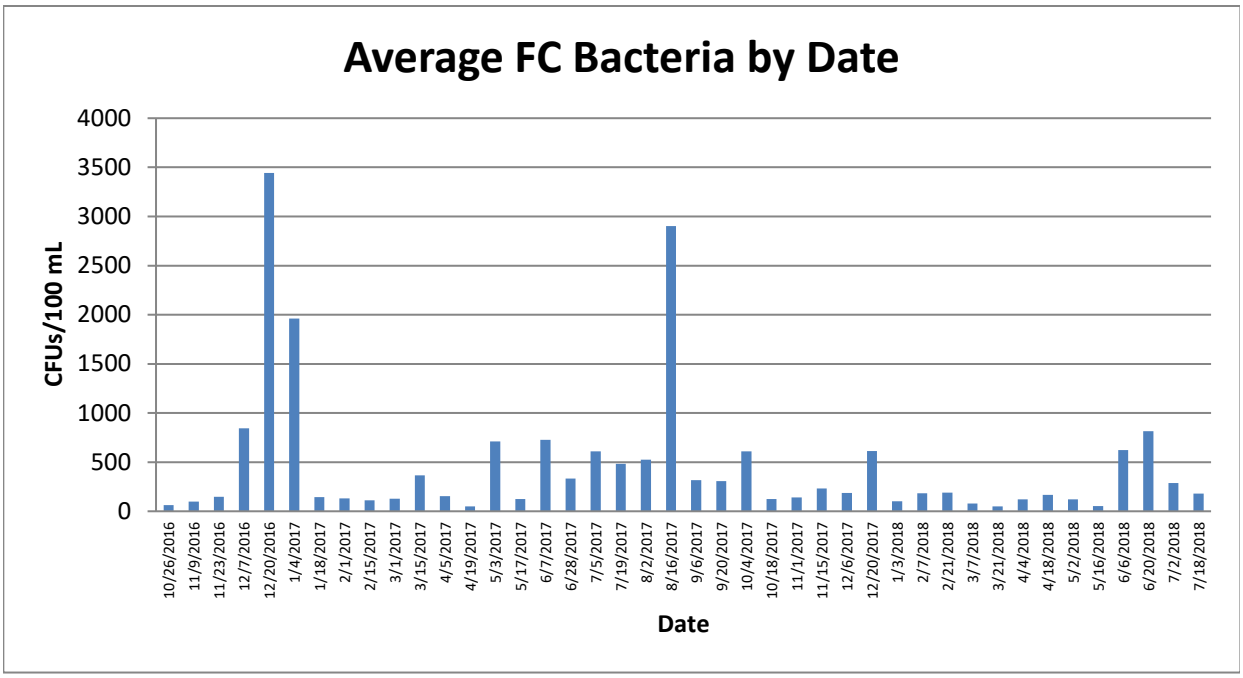

Figure 13 Graph showing the average of Fecal Coliform Bacteria for each sampling event

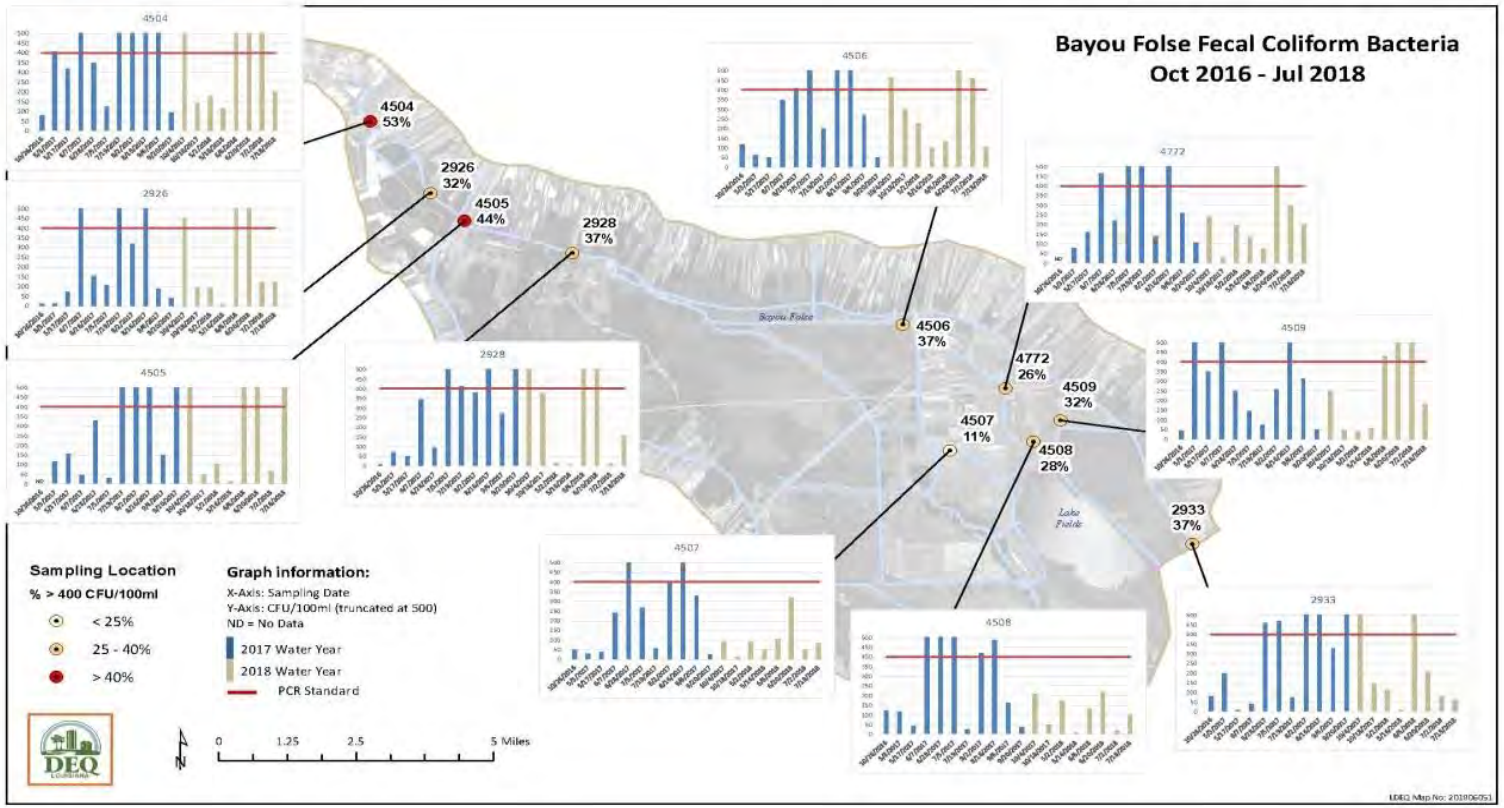

Figure 14 Map of PCR by sampling site in the Bayou Folse watershed

Total Phosphorus

Samples for TP ranged between 0.0 – 34.6 mg/L for all events sampled as part of this report (Table 10). The value of 2.3 mg/L was collected from site 8 (LEAU 4509) corresponds to a sampling event conducted on 11/9/2016. Also, the value of 34.6 mg/L was collected from site 10 (LEAU 4772) on 9/6/2017 (Table 10). Each of these values is significantly higher than all of the other values collected for other sampling events and other sites. The sources and causes of these two anomalous events are unknown. Accordingly, Figure 15 shows Site 10 as having the highest average TP values. However, the next highest value is for Site 8 and otherwise there is a general trend of a decrease along the sampling transect with Sites 8 and 10 as the anomalies in this trend.

Table 10 Average, Minimum, and Maximum of total phosphorus (TP)

Site number	LEAU Numbers	Average	Min TP (mg/L)	Max TP (mg/L)
1	4504	0.3	0.0	0.7
2	2926	0.3	0.0	0.6
3	4505	0.3	0.0	0.6
4	2928	0.3	0.1	0.6
5	4506	0.2	0.0	0.7
6	4507	0.2	0.0	0.6
7	4508	0.2	0.0	0.6
8	4509	0.4	0.1	2.3
9	2933	0.2	0.0	0.7
10	4772	1.1	0.0	34.6

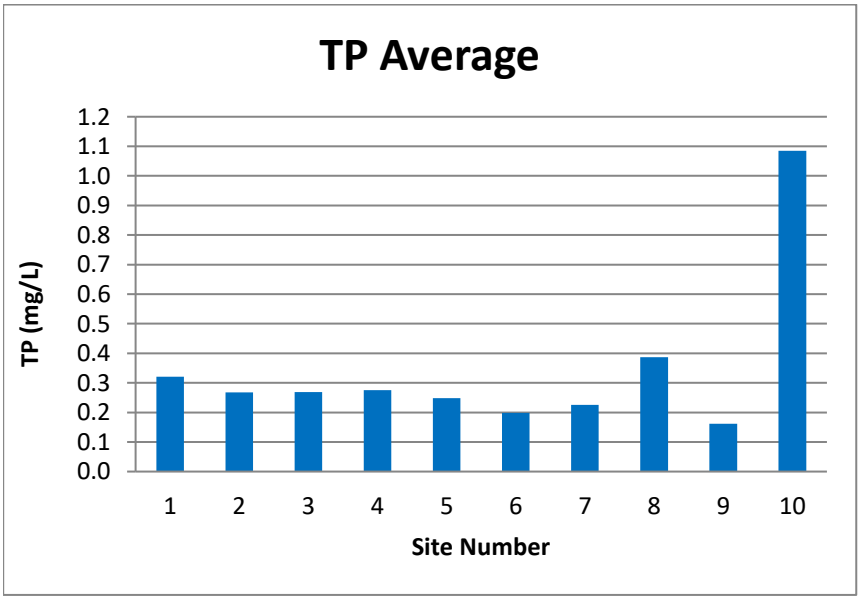

Figure 15 Graph showing the average of Total P by date

Nitrate-Nitrite

Values for nitrate-nitrite ranged from non-detection or 0.0 to 2.6 mg/L. Sites 1, 3 and 9 (LEAU 4504, 4505, and 2933) had the highest three values (Table 11). Similarly, sites 1 and 9 had the highest average values (Figure 16). Values above 2.0 mg/L were measured for five events at site 1. Values above 1.0 mg/L at site 1 were measured for 18 events.

Table 11 Average, Minimum, and Maximum of NO3-NO2

Site number	LEAU Numbers	Average	Min NO_3-NO_2 (mg/L)	Max NO_3-NO_2 (mg/L)
1	4504	1.0	0.0	2.6
2	2926	0.3	0.0	1.5
3	4505	0.4	0.0	2.4
4	2928	0.1	0.0	1.7
5	4506	0.1	0.0	1.1
6	4507	0.1	0.0	0.6
7	4508	0.1	0.0	0.9
8	4509	0.2	0.0	1.6
9	2933	0.9	0.0	2.0
10	4772	0.1	0.0	0.8

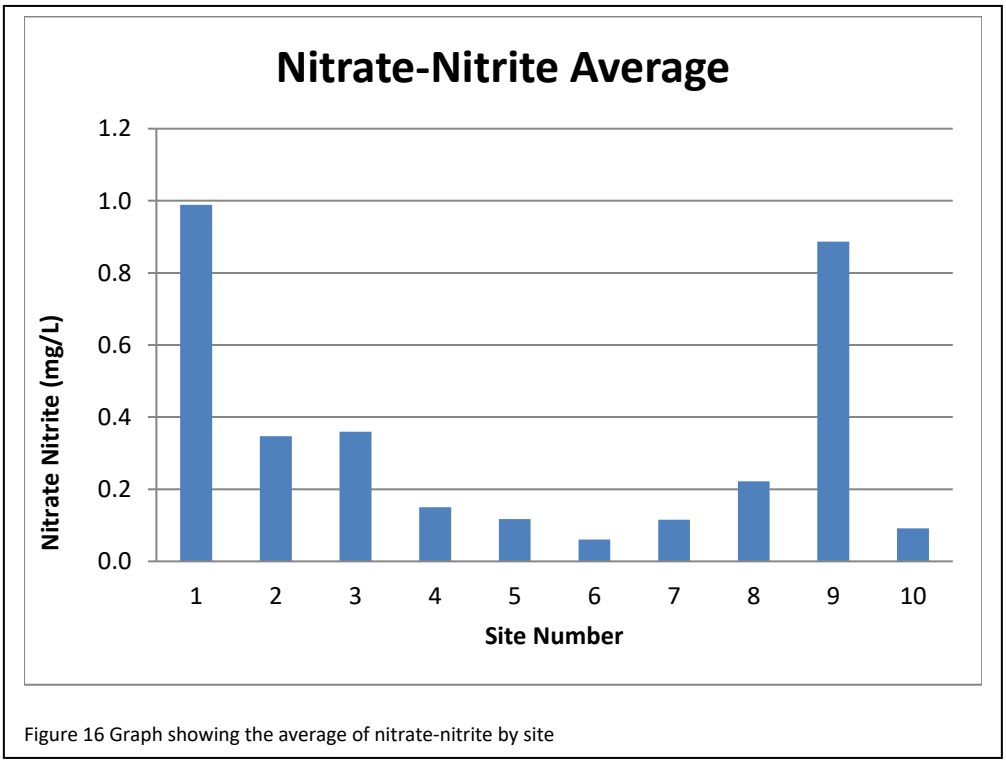

Figure 16 Graph showing the average of nitrate-nitrite by site

TKN

Values for TKN ranged from 0.1 at Site 1 to 9.5 mg/L at Site 8 (LEAU 4504 and 4509). Site 4 and Site 7 (LEAU 2928 and 4508) had the next two highest values at 2.7 mg/L and 2.6 mg/L. Table 12 and Figure 17 show Site 8 as having the highest average value. Site 9 (LEAU 4772) has a substantially lower average value than all of the other sites.

Table 12 Average, Minimum, and Maximum of TKN

Site number	LEAU Numbers	Average	Min TKN (mg/L)	Max TKN (mg/L)
1	4504	1.1	0.1	2.2
2	2926	1.2	0.3	2.4
3	4505	1.1	0.6	2.0
4	2928	1.3	0.5	2.7
5	4506	1.3	0.4	2.6
6	4507	1.3	0.7	2.2
7	4508	1.3	0.4	2.6
8	4509	1.6	0.6	9.5
9	2933	0.8	0.3	1.7
10	4772	1.2	0.6	1.8

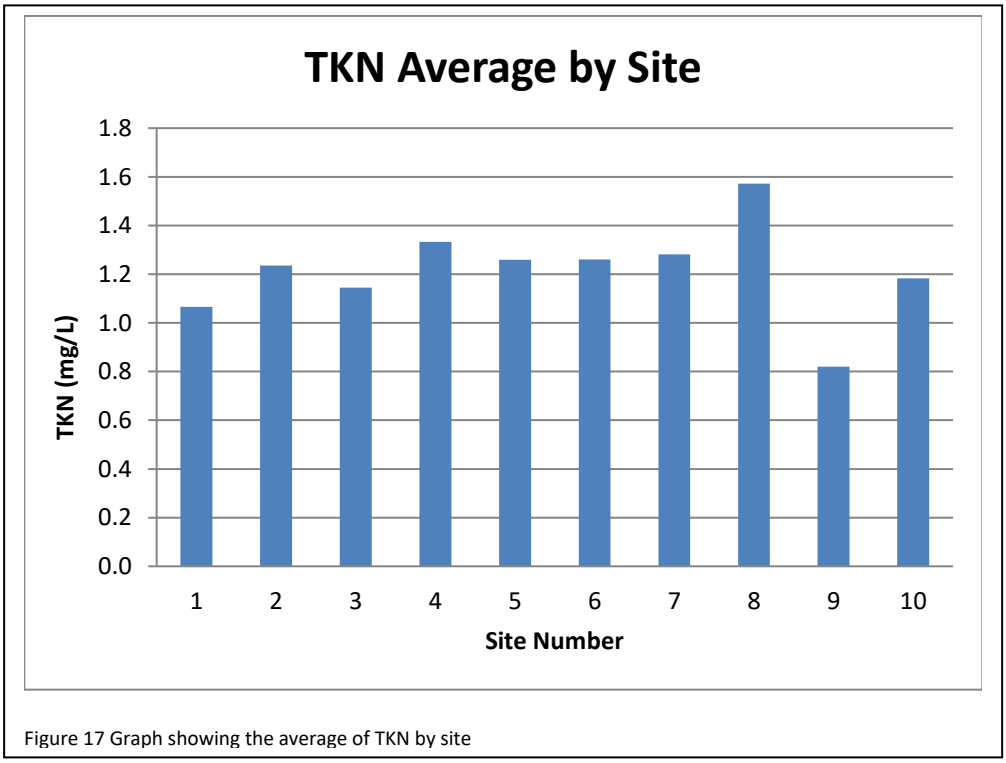

Figure 17 Graph showing the average of TKN by site

Velocity and Flow

Descriptions of how velocity was measured and how flow was calculated were outlined above in Task 2.1. Results from sampling events between 6/28/2017 and 7/2/2018 are presented in Table 13 below. Values for calculated flow ranged from 57 ft^3sec^- to 420 ft^3sec^-. This range of values is consistent with the width and depth of the waterbody at site 10 (LEAU 4772) and with values collected by LDEQ staff on a previous occasion.

Table 13 Tapedown, Flow direction, Velocity and Calculated Flow rates

DATE	TAPEDOWN	FLOW DIRECTION	VELOCITY (Ft/sec)	DROGUE FLOW (Ft^3/sec)	Max Forbes Correction factor (0.92)
6/28/2017	11.97	DOWNSTREAM	0.30	286	263
7/19/2017	12.76	DOWNSTREAM	0.30	255	234
8/2/2017	12.76	UPSTREAM	0.11	93	86
8/16/2017	12.55	DOWNSTREAM	0.27	237	218
9/6/2017	12.55	DOWNSTREAM	0.52	456	420
10/4/2017	12.11	UPSTREAM	0.22	206	189
10/18/2017	12.49	DOWNSTREAM	0.07	62	57
11/1/2017	13.28	UPSTREAM	0.34	265	244
11/15/2017	12.88	UPSTREAM	0.22	183	169
12/6/2017	12.93	DOWNSTREAM	0.19	157	145
12/20/2017	13.16	DOWNSTREAM	0.21	167	154
1/3/2018	14.41	DOWNSTREAM	0.31	196	180
2/7/2018	13.18	DOWNSTREAM	0.21	167	153
2/21/2018	12.7	UPSTREAM	0.36	309	284
3/7/2018	13.27	DOWNSTREAM	0.35	274	252
3/21/2018	13.23	DOWNSTREAM	0.42	331	304
4/4/2018	12.28	DOWNSTREAM	0.42	383	353
4/18/2018	12.71	DOWNSTREAM	0.22	188	173
5/2/2018	12.75	UPSTREAM	0.28	238	219
5/16/2018	12.9	DOWNSTREAM	0.37	307	283
6/6/2018	13.27	DOWNSTREAM	0.42	328	302
6/20/2018	14	UPSTREAM	0.18	123	114
7/2/2018	10.92	DOWNSTREAM	0.31	339	312

Within this data set both upstream and downstream bi-directional flows were represented. This is consistent with the nature of the Bayou Folse watershed given its proximity to the coast and the fact that water can be driven in both directions by storm events, tides and wind. The amount

of flow presented also seems consistent with the size of Bayou Folse at the ambient site. Given the fact that Bayou Folse is a tidally and wind influence watershed, any expectations to establish a tapedown/stage height to flow relationship can be eliminated as the velocities vary independently from flow or tapedown/stage height.

Local Government Participation

Throughout the project period, October 1, 2016 through September 30, 2018, BTNEP personnel worked with local government agencies to establish a line of authority from one local government agency that would enable BTNEP to conduct home sewage inspections in the Bayou Folse Watershed.

BTNEP attempted to partner with Lafourche Parish as other home sewage inspection programs throughout Louisiana were working through local parish governments. BTNEP had several meetings with the Lafourche Parish administration, meeting on several occasions with the Parish Administrator and the Parish President. Upon their recommendation, BTNEP sought approval for the project from the Lafourche Parish Council. BTNEP received approval from the Parish Council as a resolution where the Council voted 7-0 in support of the project. However, after consulting with their District Attorney's Office, Lafourche Parish decided that they would be unable to partner with BTNEP and LDEQ to perform home sewage inspections.

The other local government agency with authority to partner on a sewage inspection program was the Bayou Lafourche Freshwater District (BLFWD). BLFWD has jurisdiction across the parishes they provide water to (Ascension, Assumption, Lafourche and Terrebonne) and have a mission to protect water quality in those areas. Bayou Folse is part of Lafourche Parish and drains into Company Canal which is hydrologically connected to Bayou Lafourche. BTNEP had several meetings with Ben Malbrough, Executive Director of the BLFWD. BLFWD agreed to be a partner and stated their intent in a letter of interest and statement of authority to conduct home sewage inspections in the Bayou Folse Watershed. The BLFWD letter is included as part of this report (See Appendix 1).

Education and Outreach

During the length of the project, BTNEP attended various educational and outreach events each quarter where BTNEP staff conducted general water quality education to the general public and K-12 audiences. Venues for water quality education included classrooms with school children, summer camps, festivals, New Orleans Master Naturalists Training Classes, Restore Americas Estuary Conference, Leadership Terrebonne, radio interviews on KTIB in Thibodaux, BTNEP

Management Conference meetings, and garden club meetings. See Table 14 for the number and types of educational activities.

BTNEP staff used several different techniques to provide general water quality education to K-12 groups and the public. For classroom education and festivals BTNEP used various modules and activities to convey information about pollution, rainfall runoff, plastics, water clarity, surface water-groundwater connectivity, water sampling, and fisheries health as follows:

1) The Enviroscape Model. A commercially built and purchased, plastic table model showing how NPS pollution is cumulative and how small amounts of various pollutants added to a watershed over time contaminates downstream waterbodies. We often used this model at festivals and in classrooms.

2) Surface water-groundwater connectivity model. BTNEP built a surface water-groundwater connectivity model using shallow plastic containers filled with aquarium gravel. A small watershed was created by moving the gravel to one side and adding 2 toy houses and water. Colored powder was sprinkled on side of the watershed next to House 1. Then the participant made it rain on the watershed. When groundwater was pumped using a spray bottle sprayer from House 2, the participant can see that the colored powder had contaminated the groundwater under House 2 and the surface water in the watershed.

3) NPS board game. Various matching pictures from an NPS activity booklet were printed out and backed with Velcro and placed on a felt display board. Picture 1 in the set shows an activity that causes NPS pollution. Picture 2 in the set shows how to clean up, fix, or prevent the problem in Picture 1. Participants are asked to match picture sets correctly.

4) Clarity tube comparison. Two water clarity tubes were assembled side by side. One tube had turbid water in it and the other had clear water. Participants were asked to measure the depth of light penetration and compare the two water clarities from the perspective of sight-feeding fish finding food in each water body.

5) Water testing for pH, water clarity, dissolved oxygen, and salinity. Using water test kits, participants at summer camps and adult groups were taught how to test for the five listed water quality parameters in water samples from Bayou Folse. This activity was usually conducted in conjunction with the macroinvertebrate indicators activity. A connection was made between clean water, macroinvertebrates, and fisheries

6) Macroinvertebrate indicators of water quality. BTNEP staff collected macroinvertebrates from Bayou Folse and taught participants to summer camps and festivals about how macroinvertebrates can indicate how polluted or clean waterbodies can be. The emphasis was

placed on how water quality is a foundational need for macroinvertebrates which form the basis of the food chain for wildlife and fish.

7) Plastics and micro plastics in the watershed. Examples of the plastics in various stages of degradation are shown to participants so they can understand how large plastic pieces erode and photo-degrade to become micro plastics that end up in the watershed. BTNEP staff discussed how microplastics are carried in rainfall runoff as nonpoint source pollution into that watershed, are carriers of toxins, and how they can be mistaken for plankton and become ingested by fish, birds, turtles, and humans.

8) Bayou Folse Powerpoint presentations. This method used a computer presentation with photographs and text slides that report on various aspects of the project and was used for formal settings. These presentations are available upon request.

9) BTNEP water quality program website. The BTNEP water quality program website discusses the concept of a watershed and the causes and sources of various pollutants in the estuary. It also provides examples of BTNEP water quality projects, including the fact sheet about Bayou Folse. The URL is as follows: www.waterquality.btnep.org.

10) Printed materials. BTNEP staff developed various printed materials for distribution to the general public including a fact sheet, 2017 annual report, Bayou Folse flyer, June 2018 BTNEP Newsletter article, and the Thibodaux Chamber of Commerce Insight Newsletter for April 2017. These printed materials are available upon request.

Table 14 Types and numbers of educational activities

Education/Outreach Events	**2016-17**	**2017-18**	**Total**
Presentations	6	5	11
Classroom outreach	13	8	21
Festival Tabling	5	8	13
Meetings and Conferences	9	4	13
Clubs	2	0	2
Radio Interviews	1	3	4
Total	**42**	**32**	**74**
Action	**2016-17**	**2017-18**	**Total**
Website and media (Developed flyers, newsletters, and a fact sheet. The BTNEP newsletter and fact sheet was funded through 320 funds)*	6	4	10

*For examples of the factsheet, flyer and newsletters see Appendix 2-5.

Educational Images

Figure 18 Water Quality Education for the summer camp at the National Park Service

Figure 19 Water Quality Education for the Ocean's fest at Audubon Aquarium

Figure 20 Water Quality Education for the Master Naturalist at Bayou Dupont

Figure 21 Water Quality Education for Nicholls State University Summer Camp

Figure 22 Water Quality education at the Audubon Zoo World Wetlands day celebration

Figure 23 Water quality testing with the summer camp kids at the National Park Service

Figure 24 Water Quality Education for the Leadership Terrebonne

Figure 25 Vertebrate and macro invertebrate sampling with the Leadership Terrebonne group

Figure 26 Olajawon Jimoh (BTNEP Intern) doing water quality education at Audubon Aquarium

Figure 27 Water Quality Education for the Water Wonders festival at the Louisiana Children's Museum

Figure 28 BTNEP staff presenting to Laterre Garden Club Houma Library 3.22.2017

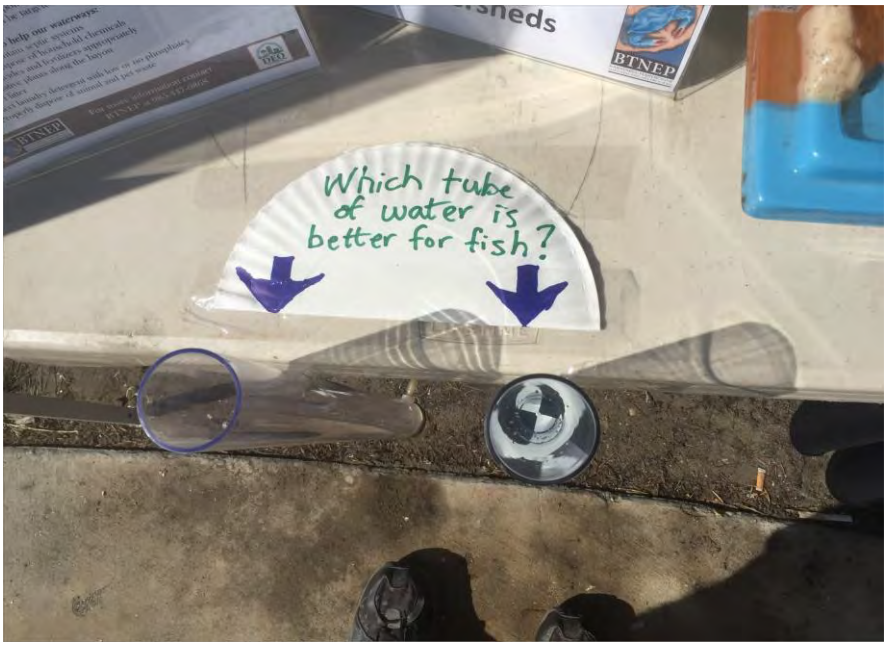

Figure 29 Water Quality Education at the Swamp Stomp Festival 11.05.16

Figure 30 Girl Scout instructing fellow Girl Scouts about NPS pollution and watersheds at the Believe in Girls (B.I.G.) Event at UNO, September 29, 2018

Conclusions

The main goal of this project was to improve the water quality in the Bayou Folse watershed by reducing the nutrient and bacteria loading in the area surrounding the watershed. We accomplished the initial steps towards that goal by collecting and establishing baseline water quality data; by negotiating a partnership with a local government agency to conduct home sewage system inspections for the next phase of the project; and by conducting a water quality education campaign in the Bayou Folse Watershed area. Baseline data for dissolved oxygen, fecal coliform bacteria, nutrients (TP, NO_3-NO_2, and TKN), and field parameters were collected at 10 sites over a two year period and 42 sampling events. Data collected for DO between 2016 and 2018 shows that for the number of DO events below 5.0 mg/L, Sites 2 and 1 (LEAU 2926 and 4504) had the highest number of sampling events or exceedances below the 5.0 mg/L standard. Site 9 (LEAU 2933) had the lowest number of exceedances. Data collected for salinity shows the highest values associated with site numbers 1, 2, 8 and 9 (LEAU 4504, 2926, 4509, and 2933). Site 1 is the uppermost site in the watershed; whereas, site 8 and 9 are near the bottom of the watershed. However, there was no salinity levels measured above what would be considered biologically fresh water. Data collected for temperature tended to follow the normal seasonal trends. Data collected for pH ranged between 6.10 and 8.92. These values represent a dramatic range of pH values. Low pH values are probably driven by organic acids from marsh and swamp drainage in the watershed; whereas high pH values are probably driven by a combination of high carbonates and photosynthetic processes. Data collected for fecal coliform shows that sampling sites 1, 3, 4, 5, and 9, corresponding to LEAU numbers 4504, 4505, 2928, 4506, and 2933 are the five sites with the highest number of exceedances for the Bayou Folse Watershed. All sites had exceedances over 25% for sampling events in this time period except for site 6, LEAU 4507, which was at 11%. Data collected for total phosphorus ranged between 0.0 – 34.6 mg/L. Anomalously high values of 2.3 mg/L from site 8 (LEAU 4509), collected on 11/9/2016 and 34.6 mg/L from site 10 (LEAU 4772), collected on 9/6/2017 have unknown sources and causes. Data collected for nitrate-nitrite ranged from 0.0 to 2.6 mg/L. Sites 1, 3 and 9 had the highest three values and sites 1 and 9 had the highest average values. Data collected for TKN ranged from 0.1 at Site 1 to 9.5 mg/L at Site 8 (LEAU 4504 and 4509). Site 8 had the highest average value; whereas, Site 9 (LEAU 4772) has a substantially lower average value than other sites. Data collected for velocity and calculated flows ranged from 57 ft^3sec^- to 420 ft^3sec^-. Within this data set both upstream and downstream bi-directional flows were represented, which is consistent with Bayou Folse watershed being coastal and previous measurements. BTNEP was unable to establish a tapedown/stage height to flow relationship as the velocities vary independently from flow or tapedown/stage height. BTNEP reached an informal

agreement to conduct home sewage system inspections with the BLFWD, a local government agency in the region. The BLFWD has the authority to conduct home sewage inspections and agreed to a partnership in a letter of interest to BTNEP. BTNEP developed and distributed various flyers, fact sheets and newsletters about water quality problems and actions that citizens could take to minimize pollution. BTNEP conducted various educational modules about water quality being conducted in various venues such as presentations, classrooms, festivals, meetings and conferences, clubs, and radio interviews totaling 74 events over the two year period of the contract. Next steps in the project include coordinating with agencies such as the Natural Resources Conservation Service (NRCS) and the BLFWD. Work with the NRCS will focus on the reduction of nutrient and oxygen consuming pollutants and fecal coliform bacteria in runoff from agricultural land uses in the Bayou Folse watershed. Work with the BLFWD will focus on the reduction of fecal coliform bacteria from onsite disposal systems or home sewage systems.